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Indian Standard

SPECIFICATION FOR THREE-PHASE INDUCTION MOTORS FOR MACHINE TOOLS

UDC 621·313·33·025·3 : 621·9-89

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 5

December 1987

Indian Standard

SPECIFICATION FOR THREE-PHASE INDUCTION MOTORS FOR MACHINE TOOLS

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Indian Standard

SPECIFICATION FOR THREE-PHASE INDUCTION MOTORS FOR MACHINE TOOLS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 28 January 1987, after the draft finalized by the Rotating Machinery Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard has been prepared to specify the requirements for squirrel cage induction motors intended to be used for machine tools.

0.3 This standard makes references to the following Indian Standards which should be read along with this standard:

a) IS : 325-1978 Specification for three-phase induction motors (*fourth revision*);

b) IS : 1231-1974 Dimensions of three-phase foot-mounted induction motors (*third revision*);

c) IS : 2223-1983 Dimensions of flange mounted ac induction motors (*second revision*);

d) IS : 4029-1967 Guide for testing three-phase induction motors;

e) IS : 1356 (Part 1)-1972 Electrical equipment of machine tools: Part 1 Electrical equipment of machines for general use (*second revision*); and

f) IS : 12075-1987 Mechanical vibration of rotating electrical machines with shaft heights 56 mm and higher — measurement evaluation and limits of vibration severity (*superseding* IS : 4729-1968).

0.4 The threads in centre hole of shafts of the machine tool motors should generally conform to IS : 2540-1963*. Some deviations have been permitted in Table 5 to allow the manufacturers and users to meet the present requirements. However, this clause shall be reviewed in due course.

---

*Dimension for threaded centre holes.

0.5 In Table 2, two speeds have been specified, the minimum speed shall be used for calculating the transmission ratio.

0.6 This standard has been prepared on the basis of IEMA: 1-1978 IEMA standard on electric motors for machine tools, issued by Indian Electrical and Electronics Manufacturers' Association, Bombay.

0.7 For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers three-phase squirrel cage induction motors required for chip removing type machine tools and operated on three-phase 415 V, 50 Hz system.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 325-1978† and IS : 1885 (Part 35)-1973‡ shall apply.

3. SITE CONDITIONS

3.1 The site conditions set out in **3.1** and **3.2** of IS : 325-1978† shall apply.

3.2 De-rating Factor — If the cooling air temperature exceeds 40°C, the rated output of the motor shall be calculated for 40°C by a multiplying factor given in Table 1.

TABLE 1 MULTIPLIER FACTORS FOR CALCULATING THE RATED OUTPUT AT DIFFERENT AMBIENTS

Cooling Air Temperature °C	Multiplier Factor
40	1
45	0·95
50	0·88
55	0·83
60	0·75

---

*Rules for rounding off numerical values (*revised*).

†Specification for three-phase induction motors (*fourth revision*).

‡Electrotechnical vocabulary : Part 35 Rotating machinery.

3.3 Supply Voltage and Frequency Variation — The induction motors covered by this standard shall be capable of delivering rated output with:

a) terminal voltage differing from its rated value by not more than ± 6 percent;

b) the frequency differing from its rated value by not more than ± 3 percent; and

c) any combination of (a) and (b).

3.3.1 In case of continuous operation at extreme voltage limits, the temperature-rise limits specified in Table 1 of IS : 325-1978* shall not be exceeded by more than 10°C.

3.3.2 Motors, when operated under the extreme conditions of voltage and frequency variation, may not necessarily have their performance in accordance with IS : 325-1978*.

3.4 It is assumed that the location and moisture or fumes shall not seriously interfere with the operation of motor for the machine tool. The manufacturer may be informed in case the motor is to be used in environments which are not free from fumes or other corrosive atmosphere so as to take care in the design of motor.

4. TYPE OF ENCLOSURE

4.1 The motor for machine tool shall have enclosure providing any one of the degrees of protection IP 23, IP 44 and IP 55 specified in IS : 4691-1985†. The degree of protection provided by enclosure of terminal box of the motor shall be IP 55.

5. METHOD OF COOLING

5.1 The method of cooling of motor and their designation shall be IC 01 or IC 0141 in accordance with IS : 6362-1971‡.

6. MATERIALS

6.1 All materials and components including insulated windings shall conform to relevant Indian Standards wherever these exist. Wherever it is not practicable to comply with this requirement, it shall be subjected to agreement between the manufacturer and the purchaser.

6.2 Class of Insulations of Windings — The windings of motor shall have insulation of Class E, Class B or superior as classified in IS : 1271-1985§. The limits of temperature-rise shall be in accordance with **12** of IS : 325-1978*.

---

*Specification for three-phase induction motors (*fourth revision*).

†Degrees of protection provided by enclosures for rotating electrical machinery (*first revision*).

‡Designation of methods of cooling for rotating electrical machines.

§Thermal evaluation and classification of electrical insulation (*first revision*).

7. RATINGS

7.1 Rated Voltage — The preferred rated voltage shall be 415 V in accordance with IS : 585-1962*.

7.2 Rated Frequency — The rated frequency shall be 50 Hz.

7.3 Rated Speed — The rated speeds of the motor in relation to the synchronous speeds shall not exceed the limits specified in Table 2. The minimum speed is the nominal rated speed and shall be considered as input speed for calculating the output speed in a drive [*see* IS : 1356 (Part 1)-1972 †].

TABLE 2 LIMITS FOR RATED SPEEDS OF MOTOR FOR MACHINE TOOLS

(*Clauses* 0.5 *and* 7.3)

SYNCHRONOUS SPEED (rev/mm)	OUTPUT (kW)		RATED SPEED* (rpm)	
	Above	Up to	*Min*†	*Max*
(1)	(2)	(3)	(4)	(5)
3 000	0·37	3·7	2 775	2 865
	3·7	37·0	2 865	2 955
1 500	0·37	3·7	1 370	1 415
	3·7	37·0	1 430	1 475
1 000	0·37	2·2	910	940
	2·2	37·0	940	970

*The values of rated speed are not subject to any tolerance.

†The minimum (nominal) speed may be taken as input speed for calculating output speeds.

7.4 Preferred Output — The preferred output ratings of the motor shall be in accordance with **7.3** of IS : 325-1978‡.

8. MOTORS FOR NON-PREFERRED VOLTAGE AND FREQUENCY

8.1 The requirements of **8.1** of IS : 325-1978‡ shall apply to motors meant for non-preferred rated voltage and frequency.

9. DIMENSIONS

9.1 The dimensions of foot-mounted motor for machine tool shall conform to IS : 1231-1974§. The flange mounted motor shall have dimensions in accordance with IS : 2223-1983||.

---

*Voltages and frequency for ac transmission and distribution systems (*revised*).

†Specification for electrical equipment of machine tools : Part 1 Electrical equipment of machines for general use.

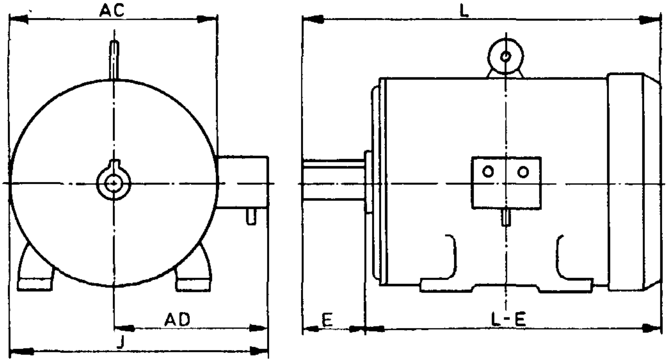
‡Specification for three-phase induction motors (*fourth revision*).

§Dimensions of three-phase foot-mounted induction motors (*third revision*).

||Dimensions of flange mounted ac induction motors (*second revision*).

9.2 The maximum overall dimensions of the foot mounted and flange mounted motors shall be in accordance with Tables 3 and 4 respectively.

TABLE 3 MAXIMUM OVERALL DIMENSIONS OF FOOT-MOUNTED MOTORS



FRAME No. (*See* IS : 1231-1974*)	MAXIMUM OVERALL DIMENSIONS IN mm		
	J†	*AD*	*L-E*
(1)	(2)	(3)	(4)
63	180	115	205
71	200	125	220
80	250	155	270
90S	280	175	270
90L	280	175	295
100L	310	190	340
112M	340	215	350
132S	400	235	400
132M	400	235	440
160M	440	265	540
160L	440	265	585
180M	485	295	590
180L	485	295	670
200L	610	375	700

NOTE — The motors may be provided with terminal box on its side or top. When the terminal box is provided on the top, dimension *J* shall be taken as total height from its base and shall be:

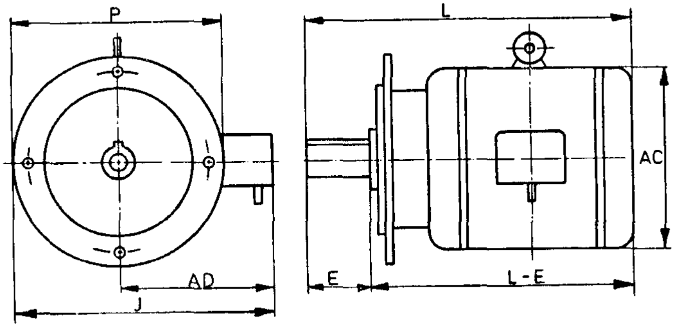
$$J = \frac{AC}{2} + AD + 10 \text{ percent of } AD$$

*Dimensions of three-phase foot-mounted induction motors (*third revision*).

$$\dagger J = AD + \frac{AC}{2}.$$

TABLE 4 MAXIMUM OVERALL DIMENSIONS OF FLANGE MOUNTED MOTORS

(*Clause* 9.2)



Flange Designation (*See* IS : 2223-1983*)		Frame Number (*See* IS : 1231-1974†)	Maximum Overall Dimensions in mm		
B Type	C Type		*J*‡	*AD*	*L* - *E*
(1)	(2)	(3)	(4)	(5)	(6)
F115B	F 75C	63	185	115	205
F130B	F 85C	71	205	125	220
F165B	F100C	80	255	155	255
F165B	F115C	90S	280	175	270
F165B	F115C	90L	280	175	300
F215B	F130C	100L	315	190	330
F215B	F130C	112M	340	215	350
F265B	F165C	132S	400	235	400
F265B	F165C	132M	400	235	435
F300B	—	160M	440	265	490
F300B	—	160L	440	265	58

*Dimensions of flange mounted ac induction motors (*second revision*).

†Dimensions of three-phase foot-mounted induction motors (*third revision*).

‡$J = AD + \frac{AC}{2} +$ or $\frac{P}{2}$ whichever is greater.

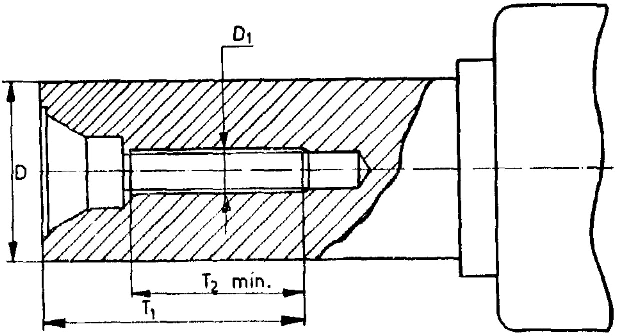
9.3 Threaded Shaft

9.3.1 Unless otherwise agreed between the manufacturer and the user of the machine tool motor (*see also* **9.3.2**), the dimensions of the threaded centre hole in the shaft shall be in accordance with IS : 2540-1963*.

9.3.2 If agreed between the manufacturer and the user of the motor, the threaded centre hole in the shaft may be provided in accordance with the values given in Table 5.

TABLE 5 THREADS CENTRE HOLES FOR MOTOR SHAFT

(*Clauses* 0.4 *and* 9.3.2)



Diameter of Shaft '*D*' (in mm)		Nominal Size of Threaded Hole	Depth of Hole (in mm)	
Over	Up to	D_1	T_1	T_2
(1)	(2)	(3)	(4)	(5)
7	10	M3*	9	6·4
10	13	M4*	10	6·8
13	16	M5*	12·5	8·5
16	21	M6 *	16	11·0
21	24	M8*	19	13·0
24	30	M10*	22	14·5
30	38	M12	28	18·5
38	50	M16	36	24·0
50	85	M20	42	27·0

*May be specifically asked at the time of enquiry.

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*Dimensions for threaded centre holes.

10. DUTY RATING

10.1 The motor for machine tools may be required to operate under different conditions of job requirement. The class of duty ratings assigned to motors has been specified in **10** of IS : 325-1978*. The class of duty of motor depends on the design and function of the particular machine tool. The class of duty of the motor shall be agreed between the motor manufacturer and the user. For ready reference, the class of duties encountered in different types of machine tools is given in Appendix A.

10.2 Attention of the motor user is also drawn to **B-1.6** and **B-1.7** of Appendix B to furnish the details of the driven tool for assessing the class of duty by the motor manufacturer.

11. EARTHING

11.1 Each motor shall be provided with earthing terminals of adequate size so as to meet the requirements of earthing specified in IS : 3043-1966†.

12. LIMITS OF TEMPERATURE-RISE

12.1 Unless agreed between the motor manufacturer and the user regarding requirements of **12.2**, the limits of permissible temperature-rise of insulated windings (*see* **6.2**) shall be in accordance with **12.1** of IS : 325-1978*.

12.2 The motor required for certain machine tools may have different requirements on the surface temperatures to make the machine tool safe for the operator. The maximum surface temperature of such motors shall be specified by the tool manufacturer (user of motor).

12.3 In applications such as work head motor for grinding machine where the surface temperature of body of the motor is critical and liable to influence the accuracy of the machine tool itself, the maximum surface temperature shall be a matter of agreement between the manufacturer and the user of motor.

13. OVERLOADS

13.1 The provisions of **13** of IS : 325-1978* shall apply.

14. LIMITS OF VIBRATION

14.1 Table 6 specifies the vibration limits on spindle in the direction of cut. Unless otherwise specified, the double amplitude of vibration of the motor shall be within the limits specified in Table 6. For determining the vibrations in motor for machine tool the method specified in IS : 12075 - 1987‡ shall be used.

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*Specification for three-phase induction motors (*fourth revision*).

†Code of practice for earthing.

‡Mechanical vibration of rotating electrical machines with shaft heights 56 mm and higher — measurement, evaluation and limits of vibration severity (*superseding* IS : 4729-1968).

TABLE 6 RECOMMENDED LIMITS FOR VIBRATION SEVERITY FOR MOTORS FOR DIFFERENT TYPES OF MACHINE TOOLS

(*Clause* 14.1)

TYPE OF MACHINE (1)	VIBRATION SEVERITY ON SPINDLE IN DIRECTION OF CUT IN MICRON DISPLACEMENT AMPLITUDE (2)	RECOMMENDED VIBRATION CLASS (*See* IS : 12075 - 1987*) (3)
Lathe	15-25	A
Drilling Machine (*Drill Size*)		
ϕ 1 mm to ϕ 5 mm high speed	4-8	B or C
ϕ 5 mm and above low speed	12-24	A
Milling Machine	5-25	A
Grinding Machine		
Threads	1·5	Special†
Profile	1-2·5	Special†
Cylindrical	1-2·5	Special†
Surface	1-5	C
Centreless	1-2·5	Special†
Boring Machine		
Jig Boring Machine	1	Special†
Normal	1·5-2·5	Special†

*Mechanical vibration of rotating electrical machines with shaft heights 56 mm and higher — measurement, evaluation and limits of vibration severity (*superseding* IS : 4729-1968).

†These require vibration level finer than precision class 'C'. The exact value which is to be met by the motor, shall be decided by agreement between the purchaser and the manufacturer.

15. PERFORMANCE VALUES

15.1 Unless otherwise specified by the user, the performance values of the machine tool motor shall be in accordance with IS : 325-1978*.

16. EFFICIENCY AND POWER FACTOR

16.1 If a statement of efficiency and power factor is required, it shall be declared at the rated load of the motor. The method of determining the efficiency and power factor shall be in accordance with IS : 4029-1967†. The tolerances applicable to the determined values shall be in accordance with Table 2 of IS : 325-1978*.

---

*Specification for three-phase induction motors (*fourth revision*).

†Guide for testing three-phase induction motors.

17. TERMINAL MARKING

17.1 The terminal marking of the motor shall be in accordance with IS : 4728-1975*.

18. RATING PLATE

18.1 A rating plate stating the following shall be provided with each motor:

a) Reference to this standard, that is, Ref ISS 12066;
b) Induction motor for machine tool;
c) Name of the manufacturer;
d) Manufacturer's number and frame No. or flange designation;
e) Class of duty;
f) Class of insulation;
g) Rated voltage;
h) Rated frequency in Hz;
j) Number of phases and winding connection;
k) Rated speed in rpm;
m) Rated output in kW;
n) Rated current; and
p) Ambient temperature if above 40°C.

18.1.1 The motor may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. BIS marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers, may be obtained from the Bureau of Indian Standards.

19. INFORMATION TO BE GIVEN WITH ENQUIRY AND ORDER

19.1 The general information to be furnished when enquiring for or ordering the motor for machine tool application is given in Appendix B.

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*Terminal marking and direction of rotation for rotating electrical machinery (*first revision*).

20. TESTS

20.1 The provision of **21** of IS : 325-1978* as applied to squirrel cage induction motors shall be applicable.

20.2 The methods of test shall be in accordance with IS : 4029-1967†.

APPENDIX A

(*Clause* 10.1)

CLASS OF DUTY OF MOTOR FOR MACHINE TOOLS

A-1. The general information on the class of duty assigned to motor is given in IS : 4722-1968‡. The class of duty for motor encountered in operation of different types of machine tools may be selected§ as follows:

Class of Duty	*Type of Machine Tool*
Continuous duty (S_1)	a) Hydraulic pump b) Lubrication pump c) Coolant pump d) Chip conveyor e) Grinding machine wheel head
Short time duty (S_2)	Rapid traverse
Intermittent periodic duty (S_3)	a) Main drive motor in gear shapers b) Main drive motor in drilling machines
Intermittent periodic duty with starting (S_4)	a) Main drive motor for lathes without clutch in the drive b) Work head motor in grinding machines c) Main drive motor in gear hobbing machines d) Coolant pump motor where frequent starting and stopping is resorted to e) Lubrication pump

---

*Specification for three-phase induction motors (*fourth revision*).

†Guide for testing three-phase induction motors.

‡Specification for rotating electrical machines.

§The user should try to give a duty cycle as close to the possible usage as the motor is likely to be used in the machine tool. The class of duty concluding the loads, rest, start and repeat cycles, if any, should be agreed between the manufacturer and the user before the final selection of the motor.

Class of Duty	*Type of Machine Tool*
Intermittent periodic duty with starting and electric braking (S_5)	Work head motor in grinding machines with electrical braking
Continuous duty with intermittent periodic loading (S_6)	Main and feed drive motor with clutches in the drive

APPENDIX B

(*Clauses* 10.2 *and* 19.1)

INFORMATION TO BE GIVEN WITH ENQUIRY AND ORDER

B-1. When enquiring for and ordering an electric motor for machine tool complying with this standard, the particulars given in this appendix should be supplied to the motor manufacturer.

B-1.1 Site Conditions — The site conditions specified in IS : 325-1978* are ambient temperature up to 40°C and altitude 1 000 m. If these conditions are different from the above, the same should be supplied as follows:

a) Ambient temperature	.........°C
b) Altitude	.........metres
c) Relative humidity	.........percent
d) Any corrosive fumes of acid or alkali present in the location	....
e) Area of operation	a) Hazardous b) Non-hazardous
f) Location of motor	a) Open b) Enclosed

B-1.2 Enclosures of Motor

a) Type of protection by enclosures (*see* IS : 4691-1985†)	Motor — IP 23, IP 44, IP 55 Terminal Box — IP 55
b) Type of cooling (*see* IS : 6362-1971‡)	a) IC 01 b) IC 01 41

---

*Specification for three-phase induction motors (*fourth revision*).

†Degrees of protection provided by enclosures for rotating electrical machinery (*first revision*).

‡Designation of methods of cooling for rotating electrical machines.

B-1.3 Insulation

Class of insulation (*see* IS : 1271-1985*)	a) Class E b) Class B c) Any other

B-1.4 Rated Output and Corresponding Rated Speeds

a) Single-speed motors ....kW.........rpm
b) Multi-speed motors, speed 1 ....kW.........rpm
speed 2 ....kW.........rpm
speed 3 ....kW.........rpm
speed 4 ....kW.........rpm

B-1.5 Electric Supply Conditions — In accordance with IS : 325-1978† the tolerance on voltage is ± 6 percent and frequency ± 3 percent, please state the values if these are different:

a) ....Volts	.........Tolerance
b) ....Frequency	.........Tolerance
c) Supply connections	3 Ph-3 wire or 3 Ph-4 wire

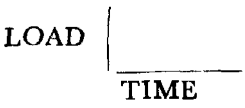
B-1.6 Characteristics of Motor

a) Constant power variable torque

b) Constant torque variable power

B-1.7 Class of Duty

Give details:

a) Whether motor has to be started on	a) No load b) On load
b) GD^2 of drive with reference to motor shaft	.........kg m^2
c) A graph giving time *vs* load to indicate load characteristic of driven machine tool	

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*Thermal evaluation and classification of electrical insulation (*first revision*).
†Specification for three-phase induction motors (*fourth revision*).

d) Time required for motor to accelerate from rest to its rated speed ....Seconds

e) Starting current limitations, if any ....Amps

f) Method of starting
  a) Direct on line
  b) Star-delta

g) Method of braking
  a) Plugging
  b) Mechanical
  c) dc
  d) Capacitor
  e) Any other method

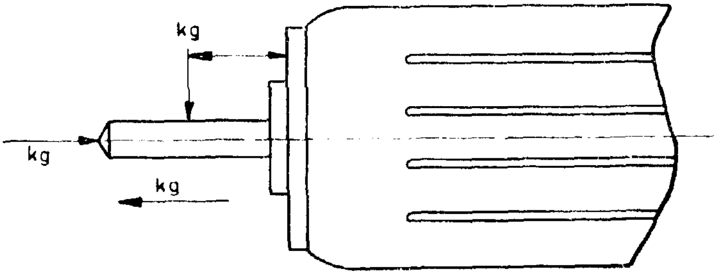
h) Method of reversal
  a) Plugging
  b) Starting from rest

B-1.8 Details of Drive

a) Type of drive
  Belt : Flat Belt/V Belt/Chain
  Gear : Spur/Helical/Bevel

b) Maximum axial play of shaft ....mm

c) Magnitude, direction and point of application of load on motor shaft



NOTE — The loads mentioned should be actuals without consideration of any other factors.

B-1.9 Mounting

a) Type of mounting (*see* IS : 2253-1974*) ....

b) Type of flange, if flange mounted (*see* IS : 2223-1983†) B Type C Type

B-1.10 Position of Terminal Box when Viewed from Driving End right/left/top

B-1.11 Vibration Requirements

Vibration limitations (when determined according to IS : 12075 - 1987‡)

Normal ....Microns
Precision A ....Microns
Precision B ....Microns
Precision C ....Microns
Any other ....Microns

B-1.12 Shaft End Details (*see* IS : 1231-1974§)

a) Shaft diameter of shaft extension .... mm

b) Keyway details (closed keyway or key to be supplied with motor), if required ....

c) Threaded centre holes in the shaft Length of tapped hole from shaft and size of centre hole thread

B-1.13 Flange Mounting Accuracies (*see* IS : 2223-1983†)

a) Shaft run-out
b) Spigot run-out
c) Face run-out

B-1.14 Inspection of Motor At user's end/At manufacturer's end

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*Designations for types of construction and mounting arrangements of rotating electrical machines (*first revision*).

†Dimensions of flange mounted ac induction motors (*second revision*).

‡Mechanical vibration of rotating electrical machines with shaft heights 56 mm and higher — measurement, evaluation and limits of vibration severity (*superseding* IS : 4729-1968).

§Dimensions of three-phase foot-mounted induction motors (*third revision*).

(*Continued from page* 2)

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